

Thermal analysis of a new model of a tobacco dryer

Ricardo Oliano de Carvalho^{1*}, Miguel Borges Machado¹, Fábio Brongar Milech¹,
Giovani Castro Fuentes¹, Carlos Alberto Silveira da Luz², Gizele Ingrid Gadotti²,
Maria Laura G. S. Luz²

(1. *Agricultural Engineering student; Federal University of Pelotas, RS, Brazil;*

2. *Professor, Engineering Center, Federal University of Pelotas, RS, Brazil.)*

Abstract: The tobacco drying greenhouses, in general, are made without any coating that ensures thermal insulation and avoid heat losses, resulting in a large consumption of firewood during the drying of the tobacco. The study aims to develop an economically viable project to the producer, to avoid excessive heat loss through the walls and ceiling of a tobacco dryer, aimed at fuel economy, reduced drying time and reduces costs in process. For the current project, we considered changes of Brazilian theoretical mode, where we developed a thermal insulation system in a dryer, reaching satisfactory results, with a large reduction in energy losses and firewood consumption, resulting in a decrease in the costs of the proceedings in general. Thus, began for the development of an ideal model of a dryer the horizontal type of 25m² of useful area, up to 2.5 t of tobacco, in order to maintain the results before and/or overcome them found a constructive model to mainly benefit the producers. During the research, and analysis on the feasibility of maintaining the rock-wool as insulation materials to be used, considering his thermal and physical properties and cost/benefit as good value, economic calculations of other materials found in the market were realized, to the optimization of construction processes and reduce costs. In the structural design of concrete blocks to form walls, with their empty space filled with insulation were used. The roof was formed by double-cement tiles with rock-wool insulation inside. The furnace/ventilation group proposed was found in the market, for reasons of economic gains and constructive, with the area available for the set, designed according to the dimensions provided by the manufacturer. The main change to the existing dryer and which was taken as a basis for the work is the proposal of a thermal insulation system, linking it to an automation system of lateral openings (flaps), with the provision of temperature controllers and humidity indoors, where they are dried tobacco leaves, making these flaps open and close automatically when the humidity inside the dryer is outside the ideal, promoting greater uniformity of drying and consequent improvement in product quality. This automation means optimizing the service of the small producer, reduced energy costs and reduced fuel consumption. Theoretically, the project was efficient, concluding that with the adoption of a new constructive model with thermal insulation and automation, is viable within the current regional economic reality, with a significant reduction of energy losses and a considerable decrease in spending with firewood used in the process, therefore, with reduced environmental impact.

Keywords: Tobacco, dryer, insulation.

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1 Introduction

The drying process of tobacco leaves in the South of Brazil is done in kiln dryers made of concrete bricks. The wood is used as raw material for combustion, which must be produced from reforestation on the property in Brazil. According to Bonato et al. (2010), in 2008/2009

season 170,650 dryers were operational. They burned approximately 8.5 million cubic meters of wood, which totals around 4 Mt of it, sending 35 Mt of gases to the environment by its combustion.

Tobacco is a crop of extreme importance in Southern of Brazil (Silveira et al., 2010), with socio-economical development of the population involved. The main suppliers of raw materials in the tobacco crop come from family farms. During the 2010/2011 crop, at around 170,000 dryers were in operation, emitting 35 Mt of gases

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***Corresponding author:** Ricardo Oliano de Carvalho, Agricultural Engineering student; Federal University of Pelotas, RS, Brazil. Email: ricardo.oliano@yahoo.com.br

to the atmosphere by combustion. (Buainainn and Souza Filho, 2009)

Given the magnitude of the above numbers, it is necessary to study technical improvements in the tobacco production process, providing a reduction in the impact that these dryers promote to the environment.

The tobacco dryers loss heat through their walls and ceilings, because they do not have any internal or external insulation, or have improper manufacturing, providing a reduction of thermal energy. This condition increases the amount of wood needed for the heating process.

The study aimed to develop an economically feasible project to the producer, to avoid excessive heat loss through the walls and ceilings of a tobacco dryer, fuel economy, to reduce drying time, and to reduce process cost.

2 Material and methods

For the current project, changes of theoretical mode, a thermal insulation system in a tobacco dryer were considered. The insulation material was chosen to achieve satisfactory results, with a large reduction in energy losses and firewood consumption that could result in a decrease of process costs in general.

Thus, an ideal dryer model, with 25m² of useful area, for up to 2.5 t of tobacco was developed, in order to overcome a constructive model to benefit mainly the producers.

Different types of insulation materials were studied. The way to build the dryer with the insulation material was studied too, as well as an automated system to control the drying process.

Heat Flow (Q) equations were studied to select the most appropriate insulation material.

3 Results and discussion

In the project, a structural design of concrete blocks to form walls, with their empty space filled with rock wool insulation (Figure 1) was used. The roof was formed by double-cement with rock wool insulation between the tiles (Figure 2) subsequently sealed at its ends. The

whole furnace/ventilation proposed was found in the market, for reasons of economic gains and constructive, with the area available for the set, designed according to the dimensions provided by the manufacturer.

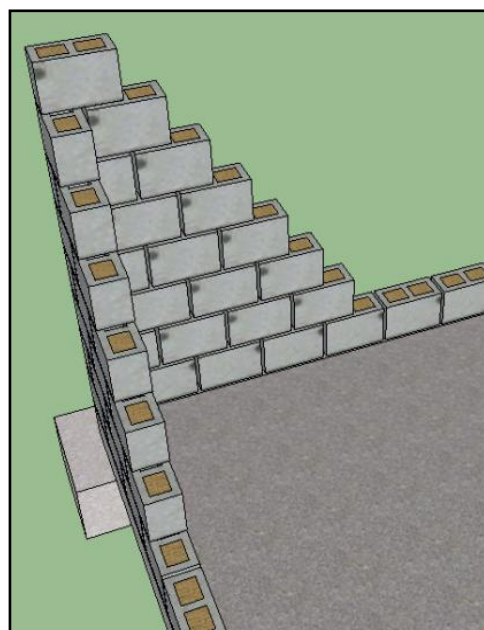


Figure 1 Walls made of rock wool between the concrete blocks

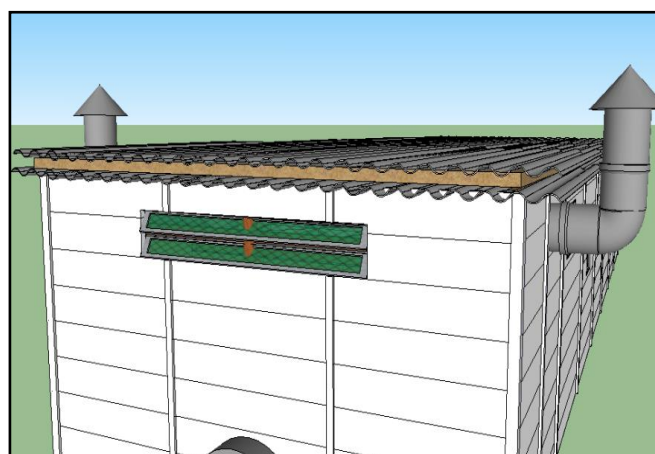


Figure 2 Roof made of double-cement tiles with rock wool inside

The main change to the existing dryers, which was taken as a basis for the work, is the proposal of a thermal insulation system, linking it to an automation system of lateral openings (flaps). This system provides the temperature controllers and humidity indoors. During the drying process of the tobacco leaves, these flaps open

and close automatically when the humidity inside the dryer is not the ideal, promoting greater uniformity of drying and consequent improvement in product quality. This automation means optimizing the producer labor, reducing energy costs, and reducing wood consumption.

During the research, beyond analysis on the feasibility of maintaining the rock wool as insulation material to be used, its thermal and physical properties and cost/benefit were considered. Economic calculations of other materials found in the market were realized to optimize the building processes and to reduce costs.

Data were obtained through equations Heat Flow (Q) on the walls and ceiling of the dryer with and without thermal insulation of rock wool, selected according to the cost-benefit as well as the need for it in relation to the values obtained from the calculations of heat transmission.

Thermal conductivity coefficients, thickness, and area of the component materials were considered to calculate the variation of temperature (Δt) between the inside and outside of the dryer. An average between the months of drying tobacco and their variations in temperature of the drying stage temperature was adopted. Table 1 shows a 25% reduction in both parameters regarding dryer taken as the basis for this project.

Table 1 Comparison of economic costs and energy consumption of firewood

	Real Dryer (without insulation)	Base Dryer (with insulation)	Current Dryer (with insulation)
Q (kcal)	17.836.528	327.717	254.730
Fuel (m ³)	6,63	0,12	0,09

4 Conclusion

Analyzing the data generated by this study, it is possible to conclude that the tobacco dryer without insulation loses a lot of heat through its walls and ceiling during the drying process, resulting in a greater expenditure of fuel to keep the heat required by the process inside the dryer, which forces the producer to supply it constantly.

Adopting a system of internal insulation the heat loss is reduced with an economy of 98% in fuel consumption and 87% on the amount invested with firewood, promoting considerable savings in fuel and time for the producer, which consequently have a greater operating comfort.

Theoretically, the project was efficient, concluding that with the adoption of a new constructive model with thermal insulation and automation, plus small percentage reductions on the previous research (dryer base), was feasible within the current regional economic reality, with reductions of energy losses, and a considerable decrease in spending on fuel used in the process, therefore, with reduced environmental impact.

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